IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appellants: Pryor et al.   Group: 2764

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For: Method of Predicting a Change in an Economy

APPEAL BRIEF

RECEIVED
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Group 2700

Assistant Commissioner for Patents
Washington, DC 20231

REAL PARTY IN INTEREST

Sandia Corporation of Albuquerque, New Mexico, owns the subject application.

RELATED APPEALS AND INTERFERENCES

None.

STATUS OF CLAIMS

Appellant appeals from the final rejection of Claims 1-8 and 10-17. Claim 9 has been cancelled. The Claims presented for appeal are set forth in Appendix A, attached hereto.

Claims 1-8 and 10-17 were rejected under 35 U.S.C. § 101.

STATUS OF AMENDMENTS

No amendment was submitted after Final Rejection. All amendments presented prior to Final Rejection have been entered.

SUMMARY OF THE INVENTION

The Specification teaches, and the claims embrace, a method for predicting changes in an economy, using a microsimulation model. The economy to be microsimulated comprises a plurality of decision makers, including, for example, households, government, industry, and banks, in a monetary economy. The decision makers can be represented by agents, while an agent can represent one or more decision makers. Each agent has decision rules that can determine the agent's actions. Each agent can affect the economy by affecting characteristic variable conditions of the economy or the internal state of other agents. *See* Specification, page 3, line 22 through page 4, line 9; Figure 1. Agents can communicate actions through messages. *See* Specification, page 4, line 10 through page 5, line 20; page 6, lines 2-22; Figure 2; Figure 3. On a multiprocessor level, the agents can be assigned to different processors in a computer. *See* Specification, page 5, lines 22-26.

An economy can be a monetary economy or a non-monetary economy. See Specification, page 6, line 24, through page 7, line 12; page 10, lines 7-13. For example in the U.S. economy, the gross domestic product can represent the total value of U.S. goods and services. An example of a non-monetary economy, as described in Appellants' Specification, can be a military confrontation with military capabilities, rules of engagement, campaign strategies, and battlefield communications. *See* Specification, page 10, lines 10-13; page 3, lines 25-26; and Claim 1.

Agents in a monetary economy can represent household decision makers. Each of these agents can have an internal state representing savings funds balances. Each agent can have decision rules to determine whether to purchase product from other agents, whether to borrow funds from other agents, and whether to save additional funds. *See* Specification, page 7, line 14 through page 8, line 20.

Agents also can represent industry decision makers. Each of these agents can have an internal state representing the number of employees working at the industry agent and the capital assets of the industry agent. Agents for these industry decision makers can pay wages to agents representing employees. Each industry agent can have decision rules to determine whether to modify the number of employees working at the industry, whether to purchase additional capital

assets, whether to borrow funds from other agents, and what price to charge for its products. The quantity of product produced can be a function of the numbers of employees and the capital assets. *See* Specification, page 8, line 22 through page 9, line 18.

Additionally, agents can represent bank and government decision makers. Each of these agents can have decision rules to determine whether to lend or borrow money, as well as the interest rate associated with lending or borrowing. Each agent representing a government decision maker can collect taxes from wages paid by industry agents and can pay employment funds to agents representing unemployed workers. *See* Specification, page 9, line 20 through page 10, line 5.

Agents have the capability to learn, modeling the capability of decision makers in a real economy to learn. *See* Specification, page 10, lines 15-18. Examples of agent learning are described: through determination of trends (*See* Specification, page 10, lines 19-23), through the use of probability vectors (*See* Specification, page 10, line 24 through page 11, line 10), and through probability vector changes reflecting various learning modes (*See* Specification, page 11, lines 11-15).

ISSUES

- ISSUE 1: PRE-COMPUTER OR POST-COMPUTER PROCESS ACTIVITY IS *NOT* REQUIRED IN CLAIMS 1-8 and 10-17 UNDER 35 U.S.C. § 101.

- ISSUE 2: CLAIMS 1-8 and 10-17 DO HAVE PRACTICAL UTILITY UNDER 35 U.S.C. § 101.

- ISSUE 3: CLAIM 1 IS WITHIN THE TECHNOLOGICAL ARTS UNDER 35 U.S.C. § 101.

- ISSUE 4: CLAIMS 16 AND 17 ARE *NOT* DIRECTED TO A GENERAL PURPOSE COMPUTER OR TO A SPECIFIC TYPE OF COMPUTER WITH SPECIFIC PHYSICAL STRUCTURE AND PATENTABLE UNDER 35 U.S.C. § 101.

GROUPING OF THE CLAIMS

Under Issue 1, pre- and post-computer process activity under 35 U.S.C. § 101, Claims 1-8 and 10-17 stand or fall together.

Under Issue 2, Claims 1-8 and 10-17 are grouped as follows:

- Claim 1 concerns a method of predicting a change in an economy, where the economy comprises decision makers and economic variables, and the method comprises the steps of: representing the decision makers by agents comprising internal state and decision rules and responsive to input messages, initializing each agent, processing each agent through receiving and generating messages and changes to the agent's internal state, routing output messages, determining new values for the economic variables, and outputting a representation of the change in the economy. Claim 1 is independently patentable, and does not stand or fall with any other claims.

- Claim 2 concerns the method of predicting a change in an economy, practiced on a specific type of computer comprising multiple processors, each processor assigned a subset of the agents. Claim 2 is independently patentable, and does not stand or fall with any other claims.

- Claims 3, 4, and 11 concern agent learning and modification of agent decision rules during processing. Claims 3, 4, and 11 stand or fall together.

- Claim 5 concerns the method of predicting a change in an economy, practiced on a specific type of computer comprising multiple processors, with interprocessor communication to route output messages to agents assigned to other processors. Claim 5 is independently patentable, and does not stand or fall with any other claims.

- Claims 6-8 and 12-15 concern decision makers comprising household decision makers, industry decision makers, and bank decision makers. Claims 6-8 and 12-15 stand or fall together.

- Claim 10 is limited to a method of predicting a change in an economy using a simulation model, and is practiced on a specific type of computer, a multiprocessor computer. Claim 10 is independently patentable, and does not stand or fall together with any other Claims.

- Apparatus Claims 16 and 17 concern a specific type of computer, a multiprocessor computer, comprising a plurality of processors with each processor comprising intraprocessor message

communication for routing messages within the processor, interprocessor communications for routing messages among the plurality of processors, independently accessible data storage, and independently accessible software storage; and means for controlling operations of the plurality of processors, processing means for each agent, means to determine new values for variable conditions, and means for outputting a change in the economy based on a difference between initial values and the new values for the variable conditions. Claim 17 recites agent learning with modification of agent decision rules. Claims 16 and 17 stand or fall together.

Under Issue 3, Claim 1, concerning a method of predicting a change in an economy, where the economy comprises decision makers and economic variables, is independently patentable, and does not stand or fall with any other claims.

Under Issue 4, Claims 16 and 17, concerning a specific type of computer, a multiprocessor computer, and concerning agent learning with modification of agent decision rules, stand or fall together.

Issue 1: ***Pre-computer or Post-Computer Process Activity is NOT Required in Claims 1-8 and 10-17 under 35 U.S.C. § 101***

EXAMINER'S RATIONALE

The Examiner stated that Claims 1-8 and 10-17 do not provide either pre-computer activity or post-computer process activity. The Examiner stated that the steps of Claims 1 and 10 relating to representing decision makers, initializing the internal state of each agent, and generating and routing messages are considered to be necessary antecedent steps to performance of the mathematical operation or determination of new values and that the step of outputting a representation of the changes merely conveys the result of the operation. The Examiner stated that the claims dependent therefrom also do not provide pre- or post-computer process activity but rather describe the mathematical process or determination or description of the input necessary for the determination.

The Examiner stated that messaging in Claims 16 and 17 amounts to input/output necessary for the processing operations of predicting a change in the economy.

ARGUMENT: PRE- AND POST-COMPUTER PROCESS ACTIVITY ARE MERELY EXAMPLES OF UTILITY AND ARE NOT REQUIRED BY 35 U.S.C. § 101 IN CLAIMS 1-8 AND 10-17:

While the Court in Diamond v. Diehr, 450 U.S. 175 indicated that a claim including non-trivial pre- or post solution activity was patentable under 35 U.S.C. § 101, the Courts have never indicated that such is the only test for determining patentablity under 35 U.S.C. § 101.

The case of *AT&T v. Excel Communications, Inc.* is an **example of a process performed entirely within a computer.** "The Court of Appeals for the Federal Circuit followed the *State Street* analysis of applying a practical application test and found the claimed subject matter was properly **within the statutory scope of Section 101**....[It focused] on the 'ultimate issue' inquiry of determining whether there was a useful, concrete and tangible result...." *See* Journal of the Patent and Trademark Office Society, Vol 81, No. 9, 1999, p. 675, on Patent No. 5,333,184, and referencing 50 USPQ2d at 1448.

AT&T Corp. v. Excel Communications Inc. No. 98-1338, April 14, 1999, the U.S. Court of Appeals Federal Circuit again addressed the scope of patentable subject matter under 35 U.S.C. § 101. **"Method claims containing mathematical algorithms need not involve physical transformation or conversion** ... to constitute patentable subject matter under 35 U.S.C. §101, since 'physical transformation' is merely one example of how mathematical algorithm may bring about useful application, not invariable requirement.... Whether process claim is directed to mathematical algorithm that is not applied to or limited by physical elements has little, if any, bearing on determining whether claim encompasses statutory subject matter, since mere fact that claimed invention involves inputting, calculating, outputting, and storing numbers would not render invention nonstatutory subject matter unless its operation does not produce 'useful, concrete, and tangible result.' " *See* 50 USPQ2d at 1447 (1999) on *AT&T Corp. v. Excel Communications Inc., no. 98-1338..*

U.S. Patent No. 5,333,184 (*AT&T* patent) adds a data field into a standard message record to indicate a primary long-distance service (interexchange) carrier or PIC. The PIC indicator, which can exist in several forms, enables long-distance service (interexchange) carriers to provide differential billing for calls on the basis of the identified PIC.

Accordingly, while pre- and post-computer process activity are examples of utility, they are not definitive of the requirements of 35 U.S.C. § 101 for Claims 1-8 and 10-17.

ISSUE 2: CLAIMS 1-8 AND 10-17 HAVE PRACTICAL UTILITY AND ARE PATENTABLE UNDER 35 U.S.C. § 101

EXAMINER'S RATIONALE:

The Examiner stated that Claims 1-8 and 10-17 do not have practical utility. The Examiner stated that Claim 1 does not claim a practical application in the technological arts.

The Examiner stated that while Claims 2 and 10 are within the technological arts, the claims do not provide a practical application. The Examiner stated that the claims dependent therefrom also do not provide a practical application but rather describe the mathematical process or determination or description of the input necessary for the determination.

The Examiner stated that the preambles of Claims 1 and 10 merely set forth the intended use or field of use of predicting a change in the economy and do not set forth a practical application.

The Examiner stated that Claims 16 and 17 are not limited to a practical application since the output, or result, is not used in any practical manner or application.

ARGUMENT: PREDICTING BEHAVOIR OF AN ECONOMY IS A PRACTICAL APPLICATION

The Examiner cited *Negishi*, U.S. Patent 5,444,819 (1995), as pertinent to Appellant's disclosure. *Negishi* claims a system for economic prediction and analysis. ***Negishi* is *prima facie* evidence that predicting an economy has practical utility.**

Computer modeling of complex phenomena is recognized as a practical application. *See, e.g., Gardner et al.*, U.S. Patent 5,754,447 (1998), "Process for predicting structural performance of mechanical systems".

A method of predicting a change in an economy , where the ecomony comprises a plurality of decision makers and economic variables have initial values is patentable under 35 U.S.C. §101, as having practical utility, as further evidenced by the following issued U.S. patents:

- U.S. Patent 5,963,648 (1999), Electronic-monetary system;

- U.S. Patent 5,987,470 (1999), Method of data mining including determining multidimensional coordinates of each item using a predetermined scalar similarity value for each item pair;

- U.S. 5,809,484 (1998), Method and apparatus for funding education by acquiring shares of students future earnings;

- U.S. 5,949, 045 (1999), Micro-dynamic simulation of electronic cash transactions;

- U.S. 5,870,724 (1999), Targeting advertising in a home retail banking delivery service; and

- U.S. 5,521,814 (1996), Process optimization and control system that plots inter-relationships between variables to meet an objective.

The Federal Circuit emphasized that the **threshold of the §101 utility requirement** is not high and stated that an "invention is 'useful' under §101 if it is capable of providing some identifiable benefit." Juicy Whip, Inc. v. Orange Bang, Inc., Docket No. 98-1379 (Fed. Cir. August 6, 1999). *See also* McDermott, Will & Emery, Intellectual Property Update, August 1999, Vol. 2, No. 8. A model of an economy is a practical application.

CLAIMS ARE NOT DIRECTED TO MANIPULATION OF ABSTRACT IDEAS DEVOID OF ANY LIMITATION TO A PRACTICAL APPLICATION:

For a 35 U.S.C. § 101 rejection based on lack of limitation to a practical application, the Office has the burden to establish a *prima facie* case that the claimed invention taken as whole is directed to the manipulation of abstract ideas devoid of any limitation to a practical application. *See* MPEP § 2106, Section IV.B.2(e). Appellants submit that such a *prima facie* case has not been made because the claims in this application are limited to a practical application in the technological arts: predicting a change in an economy. Appellants' claimed invention of a method and apparatus for predicting a change in an economy is not a data structure per se, nor is it a computer program per se, nor is it non-functional descriptive material (e.g., music, literary works, mere data) per se, nor it is a naturally occurring phenomenon. *See* MPEP § 2106, Table A-2. Original claims are directed to a method with steps to be performed. The claims do not merely manipulate an abstract idea or perform a purely mathematical algorithm devoid of any limitation to a practical application. None of the claims recite an algorithm; the claims recite

functional steps such as: representing, initializing, receiving, generating, routing, determining, and outputting. Accordingly, the claims are not directed to the manipulation of abstract ideas devoid of any limitation to a practical application.

Further, the application of Appellants' invention has **practical utility** in the technological arts. An economy can be a monetary economic system or can be a non-monetary economy, with practical applications in each area. For example, there is "real-world" value in applying Appellants' invention to predict economic vulnerability to variable economic influences. In addition, a non-monetary economy can include system capabilities, options, decision rules for strategy selection, and communications between decision makers. There is "real-world" value in applying Appellants' invention to a non-monetary economy (for example, a military confrontation with military capabilities, rules of engagement, campaign strategies, and battlefield communications). *See* Specification, page 10, lines 10-13. Appellants' invention can be applied to a hypothetical system to predict experimental outcomes (i.e., changes in an economy) by simulating complex interactions, decision rules, and options, which cannot be adequately described by closed-form, analytic equations, and which may have no historical data from which to apply traditional regression and forecasting techniques. Appellants' invention thus provides a **useful tool** for solving difficult problems, and the claims are limited to application on these difficult problems.

A PRACTICAL APPLICATION HAS A USEFUL, CONCRETE, AND TANGIBLE RESULT

Patent protection is limited to inventions that possess a certain "real world" value. "A **practical application** must be **within the useful arts**, employing technology to realize a practical application.... The definition of 'technology' is the 'application of science and engineering to the development of machines and procedures in order to enhance or improve human conditions, or at least to improve human efficiency in some respect.' Computer Dictionary 384 (Microsoft Press, 2d ed. 1994)." (emphasis added) . *See* Journal of the Patent and Trademark Office Society, Vol 81, No. 9, 1999, p. 677, quoting MPEP § 2106, Section II.A.

"[A]fter Diehr and Alapat, the mere fact that a claimed invention involves inputting numbers, calculating numbers, outputting numbers, and storing numbers, in and of itself, would not render it nonstatutory subject matter, unless, of course, its operation does not produce a **'useful,**

concrete and **tangible result.'** " (emphasis added) *See State Street*, 149 F.3d 1368; 1998 U.S. LEXIS 16869; 47 U.S.P.Q.2D (BNA) 1596, p.9 quoting Alappat, 33 F.3d at 1544, 31 U.S.P.Q.2D (BNA) at 1557. "After all, ... every step-by-step process, be it electronic or chemical or mechanical, involves an algorithm in the broad sense of the term. *See State Street*, 149 F.3d 1368; 1998 U.S. LEXIS 16869; 47 U.S.P.Q.2D (BNA) 1596, p.9.

In *Diamond v. Diehr*, the Supreme Court pointed out that "the respondents here do not seek to patent a mathematical formula. Instead, they seek patent protection for a **process** of curing synthetic rubber." (emphasis added). *See* 50 USPQ2d at 1450 (1999) quoting *Diamond v. Diehr*, 450 U.S. at 187.

In *State Street*, the Federal Circuit held that "the **transformation of data** ... by a machine through a series of mathematical calculations into a final share price, **constitutes a practical application** of a mathematical algorithm, formula, or calculation, because it produces 'a useful, concrete and tangible result' -- a final share price momentarily fixed for recording and reporting purposes and even accepted and relied upon by regulatory authorities and in subsequent trades." (emphasis added). *See* Journal of the Patent and Trademark Office Society, Vol 81, No. 9, 1999, p. 674-675, quoting *State Street*, 49 F.3d at 1373, 47 USPQ2d at 1601.

In State Street, the court concluded that "[u]npatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not 'useful.' ... [T]o be patentable and algorithm must be applied in a 'useful' way." *See* 50 USPQ2d at 1451 (1999) quoting 149 F.3d at 1373, 47 USPQ2d at 1601. "In that case, the claimed data processing system for implementing a financial management structure satisfied the § 101 inquiry because it constituted a "practical application of a mathematical algorithm, ... [by] produc[ing] 'a useful, concrete and tangible result.' " *See* 50 USPQ2d at 1451 (1999) and quoting 149 F.3d at 1373, 47 USPQ2d at 1601.

APPELLANTS' INVENTION IS A PRACTICAL APPLICATION PROVIDING USEFUL, CONCRETE, AND TANGIBLE RESULTS

Appellants' invention is a **practical application** providing useful, concrete, and tangible results -- predicting a change in an economy. The present invention acts with a model of an economy --

a **representation of real objects and relationships** between objects using simulated actors and entities -- to provide useful, concrete, and tangible results. The present invention predicts behavior of models too complex to represent without the present invention, which can use a multiprocessor computer and simulate agent learning under incomplete data. *See* Appellants' Claims and Leijonhufvud, Section II, lines 74-76. Predicting behavior for a real system is **useful,** for example: to test system alternatives; to measure anticipated performance or system changes; to assess design; to analyze procedures and system performance; to determine system drivers by testing the sensitivity of simulation results to changes in input data; and to forecast and to aid in planning future developments. *See* Pritsker and Pegden, Introduction to Simulation and SLAM, Chapter 1, pages 1-15, 1979.

Appellant's invention **models a real thing,** an economy with specifically-defined decision makers and interrelationships between those decision makers, where the decision makers can be modeled as agents. An economy, and a model of an economy, are specific, technological things -- not abstract ideas.

As discussed in Appellants' specification (*See* Specification, page 1, line 12 through page 2, line 3), other approaches exist to address this practical problem of modeling an economy, but they rely on regression analysis and aggregate macro-data for economic forecasting parameters, which loses the details of micro-level behavior and limits the model to behavior for which there exists historical data. *See* Bennett, page 1, paragraph 1, and page 4, lines 15-25. Appellant's invention models each agent's behavior at a micro-level (Claims 1-9 and 10-15) and can use learning techniques (Claims 3, 4, 6-8, 11-15) to adapt agent behavior according to changing conditions in an economy and past experience. The claims are limited to this practical application.

PREDICTING A CHANGE IN AN ECONOMY IS A PRACTICAL APPLICATION:

An economy can be a monetary economy or a non-monetary economy. An example of a non-monetary is given in Appellant's Specification. *See* Specification, page 10, lines 10-13; page 3, line 26; and Claim 1. In the U.S. monetary economy, the U.S. Commerce Department tracks the gross domestic product (GDP) -- the total value of U.S. goods and services. The Index of Leading Economic Indicators is designed to forecast economic activity three to six months in the

future. A decline in the index suggests that rising interest rates are starting to slow the economy. The Federal Reserve can respond to GDP reports by lowering or increasing interest rates. The Federal Reserve has raised interest rates to keep the economy from overheating and to prevent an outbreak of inflation. Inflation warnings from the Federal Reserve can fuel stock market gains and/or losses and can affect the bond market as well. Various economic statistics track changes in the economy after they occur. Predicting a change in the economy before it occurs is a practical application.

A new capability for predicting a change in an economy is a practical application. Processes limited to practical applications in the technological arts, even if implemented on a computer, are statutory subject matter. "For such subject matter to be statutory, the claimed process must be limited to a practical application of the abstract idea or mathematical algorithm in the technological arts." *See* MPEP § 2106, Section IV.B.2(b)ii). Appellants submit that Claims 1-8 and 10-15 are limited to a **practical application: the prediction of a change in an economy** by processing a specific type of model thereof.

CLAIM 1 IS LIMITED TO A PRACTICAL APPLICATION

Claim 1, limited to the practical application of predicting a change in an economy, accordingly is statutory subject matter. "What is determinative is not how the computer performs the process, but what the computer does to achieve a practical application." *See* MPEP § 2106, Section IV.B.2(b)ii). A digital filtering process for removing noise and producing a correction signal is a statutory process. *See* MPEP § 2106, Section IV.B.2(b)ii). In a similar manner, the invention of Claim 1 recites an economy prediction process for predicting economy changes and producing an output representation of the change in the economy, based on initial and new values of economic variables in a complex real-world system.

The invention of Claim 1 is limited to the **practical application** of **predicting behavior** of a specific model -- a model of a **change in an economy**. Claim 1 does not merely manipulate an abstract idea or solve a purely mathematical problem without any limitation to a practical application. *See* MPEP 2100, Section IV.B.2(c) and Chart A-2. Claim 1 does not recite a mathematical algorithm. As discussed above, a method of predicting a change in an economy using a simulation model is different from a mathematical or analytic model. Simulation models

have a practical application in that they capture changes in the system by focusing on the behavior of individual components of the real-world system. Appellants' invention is a practical application that is especially useful; it can predict a change in a complex real-world system that cannot adequately be described by closed-form, analytic equations. *See* Leijonhufvud, Section II, lines 4-14, and Widman et al. Appellants teach a method for problems that are too complex to solve, and Claim 1 recites a method for solving. Claim 1, limited to the practical application of predicting behavior of a model of an economy -- a practical application that is especially useful for simulation models of complex real-world systems -- is statutory subject matter complying with 35 U.S.C. § 101.

The preamble of Claim 1 sets forth what the steps accomplish: prediction of a change in an economy. Appellants submit that the steps relating to representing decision makers, initializing the internal state of each agent, and generating and routing messages are **not** necessary antecedent steps; in contrast, they are **necessary steps** in Appellants' novel process that represents complex economic interactions by a **specific type of model**, and predicts changes in the economy by using the model. Accordingly, Claim 1 recites steps in a specific process that provides a new capability for predicting a change in an economy.

CLAIM 2 IS LIMITED TO A PRACTICAL APPLICATION

Claim 2 is limited to the practical application of predicting a change in a real-world economy. A method of predicting a change in an economy using a simulation model is a practical application, different from a mathematical or analytic model Claim 2 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application.

Claim 2 is further limited to practice on a computer with multiple processors in the practical application of predicting a change in an economy -- a practical application that is statutory subject matter complying with 35 U.S.C. § 101.

CLAIM 5 IS LIMITED TO A PRACTICAL APPLICATION

Claim 5 further defines the invention of Claim 2. Claim 5 is limited to practice on a computer with interprocessor communication facility for routing messages and recites specific steps

controlling the computer's operation. A method of predicting a change in an economy using a simulation model is a practical application, different from a mathematical of analytic model. Claim 5 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application.

Claim 5 is limited to a practical application of predicting a change in a real-world economy, reciting specific steps for controlling the computer, and is statutory subject matter complying with 35 U.S.C. § 101.

CLAIM 10 IS LIMITED TO A PRACTICAL APPLICATION

Claim 10, like Claim 1, is limited to a method of predicting a change in an economy using a simulation model, and is a practical application, different from a mathematical or analytic model. Like Claim 2, Claim 10 is further limited to practice on a multiple-processor computer, described in the specification as having the capability to perform processing in parallel -- to predict a change in an economy. Claim 10 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application.

The preamble of Claim 10 sets forth what the steps accomplish: prediction of a change in an .economy. Appellants previously amended Claim 10 to make more clear the relationship between the preamble and the steps of the method. Appellants submit that the steps relating to representing decision makers, initializing the internal state of each agent, and generating and routing messages are **not** necessary antecedent steps; in contrast, they are necessary steps in Appellants' novel process that represents **complex economic interactions** by a **specific type of model**, and predicts changes in the economy by using the model. Accordingly, Claim 10 recites steps in a specific process that provides a new capability for predicting a change in an economy.

Claim 10 is limited to **a practical application** of predicting a change in an economy, and is statutory subject matter complying with 35 U.S.C. § 101.

CLAIMS 16 AND 17 ARE LIMITED TO A PRACTICAL APPLICATION

Apparatus Claim 16 is directed to a multiprocessor computer for predicting a change in an economy. Apparatus Claim 17 is directed to a multiprocessor computer for predicting a change in an economy with means for modifying agent decision rules (agent learning).

A method of predicting a change in an economy using a simulation model is a practical application, different from a mathematical or analytic model. Apparatus Claims 16 and 17 recite a multiprocessor computer described in the specification as having the capability to perform processing in parallel and applied to a practical application: to predict a change in an economy.

Appellants' apparatus Claims 16 and 17 recite application to a novel process that represents complex economic interactions by a **specific type of model**, and predicts changes in the economy by using the model. Apparatus Claims 16 and 17 recite a multiprocessor computer for performing a practical application and accordingly are statutory subject matter under 35 U.S.C. § 101 and stand or fall together.

CLAIMS 3-4, 6-8, AND 11-15 HAVE PRACTICAL UTILITY UNDER 35 U.S.C. § 101:

Claims 3-4 and 11 recite agent learning and modification of agent decision rules during processing. Claims 6-8 and 12-15 recite decision makers comprising household decision makers, industry decision makers, and bank decision makers.

Claims 3-4, 6-8, and 11-15 are limited to the **practical application of predicting behavior** of a specific model -- a model of a **change in an economy**. These claims are further limited to a model with decision makers, agent learning, and modification of agent decision rules during processing of the model. These claims do not merely manipulate an abstract idea or solve a purely mathematical problem without any limitation to a practical application. *See* MPEP 2100, Section IV.B.2(c) and Chart A-2. A method of predicting a change in an economy using a simulation model is different from a mathematical or analytic model. Simulation models have a practical application in that they capture changes in the system by focusing on the behavior of individual components of the real-world system. Appellants' invention is a practical application

that is especially useful; it can predict a change in a complex real-world system that cannot adequately be described by closed-form, analytic equations. *See* Leijonhufvud, Section II, lines 4-14, and Widman et al. Appellants teach a method for problems that are too complex to solve and are limited to the practical application of predicting behavior of a model of an economy -- a practical application that is especially useful for simulation models of complex real-world systems.

Claims 3-4, 6-8, and 11-15 are statutory subject matter under 35 U.S.C. § 101 and stand or fall together.

ISSUE 3: CLAIM 1 IS WITHIN THE TECHNOLOGICAL ARTS

EXAMINER'S RATIONALE:

The Examiner stated that Claim 1 is not a claim in the technological arts.

ARGUMENT: A METHOD OF PREDICTING A CHANGE IN AN ECONOMY AS RECITED IN CLAIM 1 IS IN THE TECHNOLOGICAL ARTS:

The question of whether a claim reciting a method of predicting the economy is in the technological arts is subsumed in the previous issue of whether the process is a practical application. The Examiner stated that Claims 2 and 10 are in the technological arts. The difference between Claim 1 and Claims 2 and 10 is that Claims 2 and 10 recite the practice of the method on a computer. Even though "a physical transformation occurs within a computer, such activity is not determinative of whether the process is statutory.... What is determinative is not how the computer performs the process, but what the computer does to achieve a practical application. See *Arrhythmia*, 958 F.2d at 1057, 22 USPQ2d at 1036." *See* MPEP § 2106, Section IV.B.2(b)ii).

Negishi, U.S. Patent 5,444,819 (1995), teaches a system for economic prediction and analysis using a neural network. ***Negishi* is *prima facie* evidence that predicting an economy is within the technological arts.**

Appellants' invention is a tool with a specific use -- for predicting a change in an economy -- in the technological arts, and teaches a method for problems that are too complex to solve analytically. Computer simulation is the problem-solving process of predicting the future state of a real system by studying a computer model of the real system. Simulations can be performed to obtain predictive information that would be costly or impractical to obtain with the real system. Ultimately, information gained from the computer simulation contributes to decisions about the real system modeled by the simulation. *See* Widman et al., Artificial Intelligence, Simulation & Modeling, pages 15-16, 1989.

Simulation models are different from mathematical (analytic or closed-form) models -- simulation models predict the changes in the states of the model of the system by focusing on/ modeling the behavior of individual components of the real-world system. Only rarely can

complex real-world systems be adequately described by closed-form, analytic equations. *See* Widman et al. In macroeconomics, analytical methods are limited and do not allow decision-making with incomplete knowledge or with adaptive processes; more complex systems can only be investigated through computer simulations. *See* Leijonhufvud, Section II, lines 4-14 and lines 74-76. A method for predicting the behavior of models that are too complex to solve analytically is a practical application in the technological arts.

Claim 1 is in the technological arts and statutory subject matter under 35 U.S.C. § 101.

ISSUE 4: CLAIMS 16 AND 17 ARE DIRECTED TO A SPECIFIC TYPE OF COMPUTER WITH SPECIFIC PHYSICAL STRUCTURE

EXAMINER'S RATIONALE:

The Examiner stated that the hardware elements of Claims 16 and 17 are directed to a general purpose computer as described in the specification because no specific code or programming and/or no specific hardware is included.

The Examiner stated that the underlying process of Claims 16 & 17 is examined and is determined to be non-statutory since the process does not include pre-or post-processing steps such as direct measurement (as made by using sensors) or a control step based upon the result. The Examiner stated that the claims are not limited to a practical application since the output, or result, is not used in any practical manner or application.

ARGUMENT: A COMPUTER HAVING MULTIPLE PROCESSORS IS A SPECIFIC TYPE OF COMPUTER:

Apparatus Claim 16 recites a specific multiprocessor computer and therefore is statutory subject matter. Claim 16 does not encompass any and every machine for performing the underlying process. "If a claim defines a useful machine ... by identifying the physical structure of the machine ... in terms of its hardware or hardware and software combination, it defines a statutory product." *See* MPEP § 2106, Section IV.B.2(a). Claim 16 recites a **specific physical structure**: multiple processing units, each having intraprocessor message communication, interprocessor communication resources to share information with other processing units in the computer, data and software storage that is independently accessible to each processor, with each processor having the capability to process its assigned agents in parallel with other processors in the computer, and with means for controlling the operation of the plurality of processors. *See* Appellant's Specification, page 5, lines 23-26; page 6, lines 5-8.

<u>APPARATUS CLAIM 16 IS DIRECTED TO A MULTIPROCESSOR COMPUTER, WITH A SPECIFIC</u>
<u>PHYSICAL STRUCTURE, WITH DEPENDENT CLAIM 17 DIRECTED TO AGENT LEARNING, AND</u>
<u>PATENTABLE UNDER 35 U.S.C. § 101</u>

Apparatus Claim 16 is directed to a **multiprocessor** computer, a specific computer with specific physical structure. Claim 16 recites hardware limits, described or inherent, in the original specification and claims. See Specification, page 5, lines 22-26; Claim 16.

Claim 16 is directed to a computer with specific physical structure: a multiprocessor computer, with intraprocessor message communication facility for messaging within each individual processor, with interprocessor communication resources accessible from each processor with message routing to the other processors, and with data storage and software storage independently accessible from each individual processor. Claim 16 recites hardware limits, described or inherent, in the original specification and claims. *See* Specification, page 5, lines 25-26. "A practical application of a computer-related invention is statutory subject matter." *See* MPEP § 2106, Section II.A.

Step b.iv of Claim 16 recites "means for assigning each agent to at least one processing unit in the plurality of processing units". *See* Specification, Claim 16. In such an assignment, each agent can be assigned to one or more processing units (or processors) in the multiprocessor computer. Even if a specific agent is assigned to a single processing unit, other agents in the plurality of agents can be assigned to other processing units to effectively use the multiprocessor computer. *See* Specification, page 5, lines 24-26.

Accordingly, Claim 16 recites a specific type of computer and is statutory subject matter. Further as discussed above, the apparatus of Claim 16 is limited to a practical application -- predicting a change in an economy. Accordingly, the **process practiced by the apparatus** of Claim 16 is also statutory subject matter.
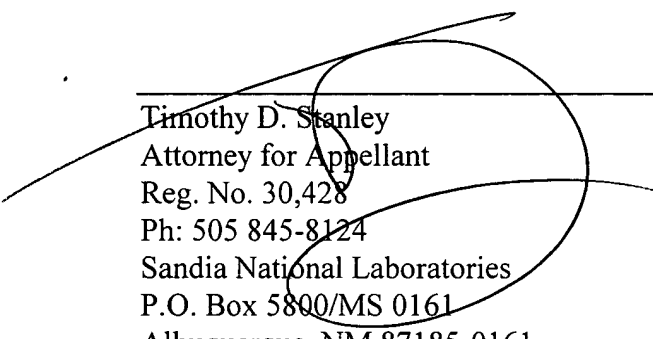
Claim 17 depends from Claim 16 and adds the capability for agent learning which can simulate decision makers in a real economy. Accordingly, Claims 16 and 17 are statutory subject matter

complying with 35 U.S.C. § 101. Appellants urge that the rejection of Claims 16 and 17 under U.S.C. § 101 be reversed.

CONCLUSION

Appellant has responded to each and every rejection and urge that the Claims as presented are now in condition for allowance. Appellant request expeditious processing to issuance.
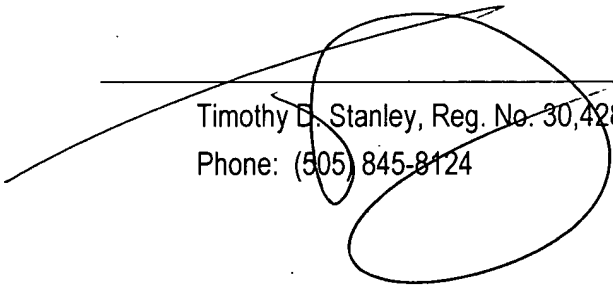
Respectfully submitted,

Timothy D. Stanley
Attorney for Appellant
Reg. No. 30,428
Ph: 505 845-8124
Sandia National Laboratories
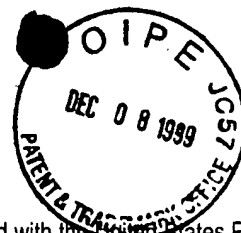P.O. Box 5800/MS 0161
Albuquerque, NM 87185-0161

TOTAL FEE DUE: **$300.00**

5.   ☒   Please charge the fee due to Sandia Corporation Deposit Account No. 19-0131.

6.   ☒   The Commissioner is hereby authorized to charge any surcharge fee deficiency which may be due on this appeal breif to Account No. 19-0131.

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Sandia National Laboratories   Timothy D. Stanley, Reg. No. 30,428
Patent & Licensing Center, MS0161   Phone: (505) 845-8124
Albuquerque, NM 87185-0161

CERTIFICATION UNDER 37 CFR 1.8

I hereby certify that this correspondence and documents referred to herein were deposited with the United States Postal Service as first class mail addressed to: Assistant Commissioner for Patents, Washington, DC 20231 on the date shown below.

Date: 12/6/99 By: Jim Stanley

APPENDIX A - CLAIMS

We claim:

Claim 1. A method of predicting a change in an economy, where the economy comprises a plurality of decision makers and economic variables having initial values, said method comprising the steps of:

a) representing the decision makers by a plurality of agents, where each agent comprises internal state and decision rules defining the agent's actions responsive to input messages and the internal state;

b) initializing the internal state of each agent;

c) processing each agent, where processing an agent comprises the steps of:

    i) receiving an input message destined for the agent, if one exists;

    ii) generating output messages and changes to the agent's internal state based on the input message, the agent's internal state, and the agent's decision rules, where an output message comprises information identifying an indicated destination agent;

    iii) repeating steps i) and ii) until there are no more input messages destined for the agent;

d) routing output messages from each agent to indicated destination agents;

e) determining new values for the economic variables from the agents' internal states and the output messages;

f) repeating steps c, d, and e until a terminal condition is reached; and

g) outputting a representation of the change in the economy based on the initial values of the economic variables and the new values of the economic variables

Claim 2. The method of Claim 1, practiced on a computer comprising a plurality of processors, additionally comprising the step of assigning each processor a subset of the agents, where each processor processes the agents assigned thereto.

Claim 3. The method of Claim 1, additionally comprising the step of modifying the agent's decision rules during the processing of the agent.

Claim 4. The method of Claim 3, wherein the step of modifying the agent's decision rules during the processing thereof comprises the steps of:

a)   generating a probability vector comprising probabilities the agent will choose among a plurality of selected actions;

b)   causing the agent to take a certain selected action based on the probability vector;

c)   determining if the economic results following the certain action were favorable or unfavorable; and

d)   adjusting the probabilities in the probability vector to increase the probability that the agent will take actions that have been followed by favorable economic results and to decrease the probability that the agent will take actions that have been followed by unfavorable economic results.

Claim 5. The method of Claim 2, wherein the computer additionally comprises an interprocessor communication facility, and wherein the step of routing output messages comprises, on each processor, the steps of:

a)   collecting the output messages from all the agents assigned to the processor;

b)   separating the collected output messages into a first group comprising output messages destined for agents assigned to the processor and a second group comprising output messages destined for agents not assigned to the processor;

c) routing output messages from the first group without using the interprocessor communication facility; and

d) routing output messages from the second group using the interprocessor communication facility.

Claim 6. The method of Claim 3, wherein the plurality of decision makers comprises a plurality of household decision makers, wherein each agent representing a household decision maker has internal state representing a saved funds balance, and where each agent representing a household decision maker has decision rules for determining whether to buy product from another agent and whether to borrow funds from another agent.

Claim 7. The method of Claim 3, wherein the plurality of decision makers comprises a plurality of industry decision makers, wherein each agent representing an industry decision maker has internal state representing a number of employees working at the agent and an amount of capital assets of the agent, and where each agent representing an industry decision maker has decision rules for determining whether change the number of employees working at the agent, whether to borrow funds from another agent, and what price to charge for the agent's product.

Claim 8. The method of Claim 3, wherein the plurality of decision makers further comprises a bank decision maker, and wherein each agent representing a bank decision maker can make loans to other agents and can accept deposits from other agents, and has decision rules for determining a first interest rate to charge on loans and a second interest rate to pay on deposits.

Claim 10. A method of using a multiprocessor computer to predict a change in an economy, where the economy has a plurality of decision makers, comprising the steps of:

a) representing the plurality of decision makers by a plurality of agents, where each agent has internal state and decision rules and can accept input messages from other agents and generate output messages for other agents;

b) assigning each agent to at least one processor in the multiprocessor computer;

c) establishing initial values for at least part of each agent's internal state;

d) establishing initial input messages for each agent;

e) determining a change in the economy by, on each processor, determining new values for the internal state of each agent assigned to the processor and new output messages from each agent assigned to the processor based on the agent's internal state, input messages for the agent, and the agent's decision rules;

f) on each processor, communicating output messages to corresponding agents;

g) repeating steps e) and f) until a terminal condition is reached; and

h) outputting a representation of the change in the economy based on the agents' internal states and the output messages.

Claim 11. The method of Claim 3, further comprising the step of modifying at least one agent's decision rules as the agent is processed.

Claim 12. The method of Claim 3, wherein the plurality of decision makers comprises a plurality of household decision makers, a plurality of industry decision makers, and a government decision maker.

Claim 13. The method of Claim 12, wherein each agent representing a household decision maker has internal state representing a saved funds balance, and wherein each agent representing a household decision maker has decision rules for determining whether to purchase product from an agent representing an industry decision maker and which agent representing an industry maker to purchase product from.

Claim 14. The method of Claim 12, wherein each agent representing an industry decision maker has internal state representing a number of employees working at the agent and the capital assets of the agent, and wherein each agent representing an industry decision maker has decision rules for determining whether to hire or fire employees and for determining whether to purchase or sell capital assets and for determining a price for the agent's product.

Claim 15. The method of Claim 12, wherein the plurality of decision makers comprises a bank decision maker, and wherein each agent representing a bank decision maker can make loans to other agents and can accept deposits from other agents, and has decision rules for determining a first interest rate to charge on loans and a second interest rate to pay on deposits.

Claim 16. A multiprocessor computer for predicting a change in an economy, where the economy comprises a plurality of decision makers and economic variables having initial values, said multiprocessor computer comprising:

    a)   a plurality of processors, where each processor comprises:

        i)   intraprocessor message communication facility within each processor;

        ii)   interprocessor communication resources accessible from each processor with message routing to the plurality of processors;

        iii)   data storage independently accessible from each processor;

        iv)   software storage independently accessible from each processor; and

    b)   means for controlling the operation of the plurality of processors, comprising:

        i)   means for representing the plurality of decision makers by a plurality of agents, where each agent comprises internal state and decision rules;

        ii)   means for initializing the internal state of each agent;

        iii)   means for inputting the initial values of the economic variables of said economy, where the economic variables are represented as variable conditions;

        iv)   means for assigning each agent to at least one processing unit in the plurality of processing units;

        v)   means for processing each agent, where processing an agent comprises:

            (1)   means for receiving an input message;

(2)   means for updating the internal state of the agent based on the input message, the current internal state of the agent, the decision rules of the agent, and the values of said variable conditions;

(3)   means for generating an output message for a destination agent; and

(4)   means for repeating (1) through (3) until there are no more input messages for the agent;

vi)   means for determining new values for the variable conditions based on a combination of the effects of the plurality of agents;

vii)   means for repeating steps v) and vi) until a terminal condition is reached; and

viii)   means for outputting a prediction of the change in the economy based on a difference of the new values for the variable conditions and the initial values;

Claim 17. The apparatus of Claim 16, further comprising means for modifying at least one agent's decision rules as the agent is processed.